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PROPELLANT POWDERS.

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This invention relates to progressive powders and more particularly to progressive burning propellant powders adapted for use in small arms such as shot guns.

The term "progressive burning" is usually applied to propellant powders used in small arms and is associated with those powders which have received a surface treatment. This treatment being either a superficial coating or an impregnation of the surface layers of the powder grain by a solid which is a solvent for the powder and usually at an elevated temperature. This serves to delay the rate of ignition and its propagation from one grain of powder to the other, thus reducing the unit pressure within the gun barrel. It will, however, be noted that a coated powder having the same base composition, will require a larger charge to produce equal velocity with an uncoated powder.

Slow burning powders, especially those having a nitro-hydrocarbon base and progressive burning, are not adapted for use in shot guns, unless the loaded shot shell is especially designed as described in application Serial Number 667,075, filed October 6, 1923. A dense nitro-cellulose colloid burns progressively, that is, in layers until completely consumed. While it is, therefore, peculiarly adapted for rifle arms where the projectile seals the bore, it is not suitable for cylinder guns and small arms. In powders for cylinder guns, it is necessary that the initial burning be at a more rapid rate, due to the fact that the bore of the gun is not sealed by the projectile. Accordingly if the pressure is not rapidly developed, incomplete burning results, since the rapidity of burning depends directly upon pressure. Accordingly where a dense nitro-cellulose powder is employed in a cylinder gun, the result will be unburnt powder and escape of the gases around the wads, thereby reducing the ballastic efficiency.

In the preparation of nitro-cellulose powder for use as military ammunition, it has further been the practice to subject the dense nitro-cellulose colloid to surface treatment by coating or impregnating the same with a suitable nitro-hydrocarbon, thereby producing a so-called progressive burning powder having a still lower initial pressure without, however, lowering the velocity of the projectile. The function of the solvent, however, is to act as a deterrent, as this solvent is not only less explosive and less readily ignitable than the dense nitro-cellulose colloid, but it acts as a surface seal; it will, therefore, be seen that this surface treatment goes still further in the opposite direction than the requirements and characteristics desired in a powder suitable for use in cylinder guns and small arms.

In order to produce a smokeless powder having a nitrocellulose base, it has been the practice heretofore to either mix with the nitro-cellulose, metallic nitrates or a more violent explosive ingredient, such as nitroglycerin. The former, however, produces smoke, while both have a corrosive action on the bore of the gun. It has also been the practice to employ weak solvents so as to only partially gelatinize the nitro-cellulose, or to employ ingredients with the nitro-cellulose while in a plastic state which are subsequently extracted. These, however, are open to the objection that they do not provide stable and uniformly burning grains.

It is a well known fact that powders of various grain, size and shape, have various rates of burning and produce various pressures and temperatures when fired in a gun barrel, e. g. a certain weight of very finely divided nitro-cellulose powder will burn very rapidly and produce high pressures while heavier grains will burn more slowly under given conditions, the largest grains will not produce sufficient pressure and temperature to completely burn the grain.

The rate of burning of a powder grain is also dependent upon the density and composition. Thus a nitro-cellulose powder grain of comparatively low density, such as the bulked smokeless powder described in my Patent No. 1,627,861, issued May 10, 1927, or even ordinary bulk smokeless powder, has a higher rate of burning than, for instance, condensed colloided nitro-cellulose powder. Also the latter in turn has a lower rate of burning than, for instance, a low nitration nitro-cellulose bulk powder or a nitro-glycerin-nitro-cellulose powder. In all of the above powders the grain characteristics determine the rate of burning.

One of the objects of this invention, therefore, is to provide a progressive burning

powder consisting of blended grains, the characteristics of which are so chosen as to cause a blended charge thereof to burn progressively.

Another object is to provide a progressive burning powder which is more reliable than surface treated powders and which for a given velocity requires a smaller charge.

Further objects will appear from the detail description in which will be disclosed a number of illustrative embodiments of this invention.

In accordance with this invention a powder is produced by selecting powder portions so that the grains of the several portions burn at progressively decreasing rates and the portions so chosen are then blended in the desired proportions so as to produce the desired progressive burning of a blended charge. While the grain characteristics of the same portion may be substantially the same, the grain characteristics of the several portions vary progressively in accordance with the desired progressive action of a blended charge.

In accordance with one embodiment of this invention the rate of burning is controlled by proper selection of the grain sizes. By proper selection of the grain sizes in the several portions, i. e., by selecting powder portions in which the sizes of the grains increase progressively in the several portions, then a blended charge will burn progressively. As an example, a powder for use in shot guns may consist of ground or cut dense colloided nitro-cellulose powder, either surface treated or untreated, and blended in the following proportions:

10% thru a 40 mesh screen on 42.
20% thru a 42 mesh screen.
20% on a 46 mesh screen.
50% thru a 46 on 60.

This powder in a trap load (shot shell) gives 882 foot seconds with a pressure of 5130 pounds per square inch as compared with the standard load (bulk smokeless) of 860 foot seconds with 8500 pounds per square inch.

In such a charge the finer or quick burning grains will ignite at a lower pressure and temperature than the coarser or slower burning grains; the temperature and pressure will, however, be maintained and even elevated by the combustion of the finer grains, to an extent sufficient to cause and maintain the combustion of the larger grains. Thus in the firing of a blended charge in which the grain sizes increase progressively, the primer need only be sufficient to start ignition of the finer grains; these will maintain the temperature and pressure necessary to ignite the next coarser grains; and so on. In this manner is produced a delayed ignition of the charge as a whole and a true progressive burning; accordingly for a blended charge the velocity is greater although the maximum pressure is less than for a standard charge as will be seen from the results given above.

In accordance with another embodiment of this invention the rate of burning is controlled by proper selection of the grain density. Thus by proper selection of, for instance, a portion of dense colloided nitro-cellulose powder and a portion of bulk smokeless powder, or a bulked nitro-cellulose powder, such, for instance, as described in my Patent No. 1,627,861, the desired progressive burning action may be obtained. The following is also an example of a rifle powder in which the grains may be of uniform size and the base nitro-cellulose.

80% high nitration powder—coated with 9% dinitrotoluene.
10% low nitration powder—coated with 5% dinitrotoluene.
10% low nitration powder—uncoated.

The above blended mixture produces velocities equal with the first 80% component of the mixture above, but with a smaller charge.

In accordance with still another embodiment of this invention the rate of burning is controlled by proper selection of the grain composition. Thus a powder adapted for use in shot gun shells containing heavy shot, such as buck shot, is as follows:

80% dense colloided nitro-cellulose powder of high nitration and coated with dinitrotoluene.
20% nitro-cellulose-nitro-glycerin powder of low nitration and uncoated.

Such a powder has given satisfactory results in high velocity buckshot loads.

An example of controlling the rate of burning by varying both the grain sizes and composition is as follows:

90%–80% ground smokeless powder (dense colloided nitro-cellulose, either coated with dinitrotoluene or uncoated) sized as follows:
66⅔% through 40 mesh on 46.
33⅓% through 46 mesh on 70.
10%–20% black powder—3 F G.

Another example of mixed grain, size and composition is as follows:

90%–80% ground smokeless—same as the preceding example.
10%–20% powder consisting of,
70% potassium nitrate.
15% barium nitrate.
15% charcoal.

The charcoal (or cellulose) may be impregnated with the potassium nitrate (or sodium nitrate) and the barium nitrate by a soaking and drying process. The above powder in a standard shot shell load gives 1037 foot seconds with 7346 per square inch as against 985, foot seconds with equal pressure when using standard load of bulk smokeless powder.

In accordance with this invention, therefore, the progressive burning action is produced by proper selection of the grain characteristics of the portions of the blended charge; and by the proper selection of the proportions of the charge portions the desired progressive burning can be obtained. This grain characteristic may be varied by variation of the size, shape, density or composi-

tion of the grain, and the selection may be of any of these characteristics or of any combination of them. In accordance with this invention the more rapid burning powders impart their energy directly to the slower burning constituents of the mixture and there is no localizing of pressure but rather a uniform increase in the rate of burning which in turn imparts a sustained drive to the projectile.

The progressive burning powder made in accordance with this invention is especially suitable for use in shot shells and such a shell may be constructed and loaded as disclosed in application Serial Number 704,124, filed April 4, 1924. In a shell using heavy wadding, and upon firing of the charge, the more readily ignitable powders will keep up the pressures and temperatures necessary to secure the desired progressive burning of the blended charge, while the heavy wadding serves to confine the blended charge. Accordingly the rate of combustion will increase so that the desired pressure is maintained, especially since the heavy wadding provides sufficient resistance to the expansion of the gases to maintain the pressure. The result is, therefore, that the combustion is uniformly accelerated, even after the confining wadding and the shot begin to move, so that the pressure is maintained nearly uniform for an extended distance along the gun barrel; the result is that the shot charge is uniformly accelerated under a lower initial pressure maintained for an extended distance along the gun barrel.

While in the specification and claims the term "grain" is used, it is to be understood that it is intended as a word of general description and not of limitation, but to include the various forms in which powder is produced for use. It will be further understood that while theories of formation and operation have been advanced, the invention is not necessarily limited thereto. It will further be obvious that various changes may be made in details without departing from the spirit of this invention; it is, therefore, to be understood that this invention is not to be limited to the specific details described. Certain features disclosed in this application are claimed in applications Serial Nos. 62,090 and 62,091, filed October 12, 1925.

Having thus described the invention, what is claimed is:

1. A progressive burning powder consisting of blended grains, the characteristics of which are so chosen as to cause a blended charge thereof to burn progressively.

2. A progressive burning powder consisting of blended portions, each portion having a characteristic which is different from that of the other, the characteristics of the grains of the several portions being so chosen as to cause a blended charge thereof to burn progressively.

3. A progressive burning powder consisting of blended portions, the characteristics of the grains of each portion being substantially the same but the characteristics of the grains of the several portions being so chosen as to cause a blended charge thereof to burn progressively.

4. A progressive burning powder consisting of blended portions, the grains of the same portion burning at substantially the same rate but the grains of the several portions burning at different rates.

5. A progressive burning powder consisting of blended portions, each portion having a grain size which is different from that of the other, the sizes of the grains of the several portions being so proportioned as to cause a blended charge thereof to burn progressively.

6. A progressive burning powder consisting of blended portions, each portion having a grain size which is different from that of the other, the sizes of the grains of the several portions and said portions being so relatively chosen as to cause a blended charge thereof to burn progressively.

7. A progressive burning powder consisting of blended grains, the sizes of which are so chosen as to cause a blended charge thereof to burn progressively.

8. A progressive burning powder consisting of blended portions, each portion having a grain size which is different from that of the other, the grains of each portion being of substantially the same size but the sizes of the grains of the several portions being so chosen as to cause a blended charge thereof to burn progressively.

9. A progressive burning powder consisting of blended portions, each portion having a grain size and density which is different from that of the other, the characteristics of the several portions being so chosen as to cause a blended charge thereof to burn progressively.

10. A progressive burning powder consisting of blended portions, each portion having a grain size, density and composition which is different from that of the other, the characteristics of the several portions being so chosen as to cause a blended charge thereof to burn progressively.

11. The process of making progressive burning powder consisting in blending powder portions in which each portion has a grain characteristic which is different from that of the other and so choosing the grain characteristics of the several portions as to cause a blended charge thereof to burn progressively.

12. The process of making progressive burning powder consisting in blending por-

tions in which each portion has a grain characteristic which is different from that of the other and so choosing the grain characteristics of the several portions and the relative proportions of these portions as to cause a blended charge thereof to burn progressively.

13. The process of making progressive burning powder consisting in selecting powder portions so that the grains of the several portions burn at progressively decreasing rates and blending the portions.

14. The process of making progressive burning powder consisting in selecting powder portions so that the grains of the several portions are of progressively increasing sizes and blending the portions.

15. The process of making progressive burning powder consisting in selecting powder portions so that the grains of the several portions are of progressively increasing sizes and densities and blending the portions.

In testimony whereof I affix my signature this 5th day of June, 1924.

ARTHUR S. O'NEIL.